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Gas Cooling Compliance Options for Residential & Nonresidential Buildings

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Presented by Davis Energy Group
on behalf of
Southern California Gas Company

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Overview

- Proposal to introduce and improve compliance options related to gas cooling equipment
  - Residential Technologies
    - Single Effect Absorption Chiller/Air Conditioner
  - Commercial Technologies
    - Double Effect Absorption Chiller
    - Gas Engine Chiller
    - Gas Engine Heat Pump

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Gas Cooling Compliance Option Background

- SCG originally proposed improvements to the gas cooling standards in the AB970 Title 24 proceedings. The CEC could not accommodate gas cooling due to the short time frame of the Emergency Regulations, and agreed to address inclusion of appropriate gas cooling compliance options within the Standards 2005 revisions
- The Statewide Codes & Standards Team (IOU's) ranked natural gas cooling as a high priority for implementation in standards updates
- The need for changes to the Gas Cooling Standards became more relevant with the introduction of the TDV methodology

Current Treatment of Gas Cooling in ACMs

- Residential
  - Micropas includes bin analysis for Gas Engine Heat Pump.
  - Single Effect Absorption Chiller in Standards table, but not described in Residential ACM Manual.
- Non-Residential
  - Absorption Chillers in Standards table and ACM Manual.
  - Gas Engine equipment not described in Standards or ACM Manual.

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Gas Cooling Benefits

- Provides end-users more options to manage and control energy use profile
- Significant electrical peak demand reduction
- Potential for customer utility bill savings, especially with time-of-use rates
- Opportunities for improved plant efficiency using heat recovery
- Reduced size of emergency power generation systems (cost savings for smaller units)

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Scope of Change

- Adds new residential compliance option for absorption cooling
- Changes non-residential compliance options
  - Adds Gas Engine Driven Heat Pump and Gas Engine Driven Chiller to ACM manual and Standards efficiency tables
  - Modifies Standards language to allow heat recovery already provided for in ACMs (but only heat from space conditioning and used for space conditioning or DWH)
  - Proposes new defaults for Absorption Chiller temperature-HIR curves.
- Applies hourly TDV model to residential and non-residential technologies

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Methodology

- Analyzed gas cooling vs baseline electric systems
- Compared flat source multiplier energy use to TDV energy use for 5 climate zones.
- Collected data from commercial equipment manufacturers to compare current equipment on market to current DOE2 eligibility criteria and default curves
- Collected data from residential equipment manufacturers to develop an ACM model.

Residential Analysis

- Used CEC standard 1761 sqft house.
- Baseline equipment = Electric, 12 SEER.
- Used MICROPAS V6.1 to generate loads file (TDV version was not yet available).
- “Standard” loads file was imported into HMG TDV Spreadsheet. This spreadsheet includes proposed 2005 changes for electric air conditioner modeling (including fan energy accounting, etc.)

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Residential Analysis (cont.)

- Applied Gas Absorption model to loads data to generate gas and electricity consumption values for the gas equipment.
- Output from model used to modify loads file to create “Proposed” case.
- “Proposed” loads files were imported into TDV Spreadsheets, which calculated Source Energy vs TDV compliance.

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Non-Residential Analysis

- Used a 7,200 sqft office bldg. Developed by Gabel Dodd/EnergySoft for Non-Res ACM tests.
- Used EnergyPro 3.1 with DOE-2.1E simulation engine to generate “Standard” and “Proposed” energy use files
- Gas Cooling equipment Inputs for EnergyPro: Equipment size, fan power, cooling HIR, heating HIR (HP only), EIR, and performance curves for the Double Effect Absorption Chiller.
- The output files were then imported into the TDV spreadsheet for the same comparison as Residential.

Efficiencies of Baseline and Proposed Equipment

	Electric Baseline	Gas Cooling	
		Current	Proposed
Residential Single Effect Absorption	12 SEER	0.60 COP	0.60 COP
	10 EER		
Non-Res Double Effect Absorption	4.45 COP	1.00 COP	1.00 COP
	Scroll	1.00 IPLV	1.00 IPLV
Non-Res Gas Engine Driven HP	9.5 EER (Cooling)	N/A	0.60 COP (Cooling)
	80% TE (Heating)		0.72 COP (Heating)
Non-Res Engine Driven Chiller	4.45 COP	N/A	1.2 COP
	Scroll		2.0 IPLV

Results - Residential Single Effect Absorption Chiller

Climate Zone	Current Method: Cooling Source Energy kBtu/sf-yr		Compliance Margin
	Standard Design Cooling Energy Budget	Proposed Design Cooling Energy Use	
6	2.36	4.50	-10.0%
10	9.43	19.25	-30.0%
12	4.93	10.29	-14.6%
13	12.67	25.96	-32.6%
14	12.01	23.98	-26.1%

Climate Zone	Time Dependent Valuation: kBtu/sf-yr		Compliance Margin
	Standard Design Cooling Energy Budget	Proposed Design Cooling Energy	
6	7.41	6.19	4.5%
10	27.24	25.25	3.9%
12	15.05	12.08	6.5%
13	29.08	28.15	1.6%
14	31.05	31.03	0.0%

Results - Non-Res Engine Driven Chiller

Climate Zone	Source Energy, MMBtu/yr		Compliance Margin
	Standard Design Energy Budget	Proposed Design Energy Use	
6	1,028.7	1,144.3	-11.2%
10	1,131.7	1,185.4	-4.7%
12	1,129.0	1,167.4	-3.4%
13	1,182.7	1,330.5	-12.5%
14	1,189.8	1,227.8	-3.2%

Climate Zone	TDV Source Energy, MMBtu		Compliance Margin
	Standard Design Energy Budget	Proposed Design Energy	
6	2,094.3	1,992.7	4.9%
10	2,306.1	2,041.4	11.5%
12	2,022.7	1,857.8	8.2%
13	2,144.0	2,053.5	4.2%
14	2,327.4	2,060.8	11.5%

Results - Non-Res Double-Effect Absorption Chiller

Climate Zone	Source Energy, MMBtu/yr		Compliance Margin
	Standard Design Energy Budget	Proposed Design Energy Use	
6	995.7	1,244.6	-25.0%
10	1,089.5	1,323.5	-21.5%
12	1,093.0	1,249.4	-14.3%
13	1,143.7	1,342.1	-17.3%
14	1,142.5	1,304.3	-14.2%

Climate Zone	Time Dependent Valuation: MMBtu		Compliance Margin
	Standard Design Energy Budget	Proposed Design Energy	
6	2,016.3	2,089.9	-3.7%
10	2,234.5	2,190.5	2.0%
12	1,967.4	1,955.3	0.6%
13	2,084.5	2,074.0	0.5%
14	2,247.0	2,155.4	4.1%

Results - Non-Res Engine Driven Heat Pump

Climate Zone	Current Method: Source Energy MMBtu/yr		Compliance Margin
	Standard Design Energy Budget	Proposed Design Energy Use	
6	1,185.4	1,221.8	-3.1%
10	1,413.2	1,517.6	-7.4%
12	1,335.0	1,377.1	-3.2%
13	1,467.3	1,574.9	-7.3%
14	1,483.9	1,539.8	-3.8%

Climate Zone	Time Dependent Valuation: MMBtu		Compliance Margin
	Standard Design Energy Budget	Proposed Design Energy	
6	2,628.6	2,234.0	15.0%
10	3,156.2	2,584.9	18.1%
12	2,646.2	2,230.0	15.7%
13	2,893.3	2,449.1	15.4%
14	3,304.3	2,671.2	19.2%

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Recommendations

- Standards
  - New definition for “GAS COOLING EQUIPMENT” in Section 101
  - Changes and additions to heat pump and chiller minimum efficiency tables 1-C2 and 1-C3 in section 112
  - Changes to Section 141 (Energy Budgets) to allow heat recovery from space conditioning equipment for use with space conditioning equipment (or DHW).

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Recommendations

- Residential ACM
  - Add reference to gas equipment in “Equipment Efficiency/Method” under Certificate of Compliance
  - Add definition for Absorption Chiller
  - Add exception to “Equipment Type” in Section 2.2: Computer Method Summary so that if Gas Abs equip is specified, it is listed in the “Special Features” list.
  - Add Gas Absorption model in Section 3.8.2 Cooling Equipment

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Recommendations

- Non-Residential ACM
  - Add section 3.5.2.3 for Gas Engine Driven Chillers and Heat Pumps
- Change default DOE2.1E coefficients
- Environmental Impact Study (EIS) in progress
  - EIS results will be integrated into the Code Change Proposal when completed.